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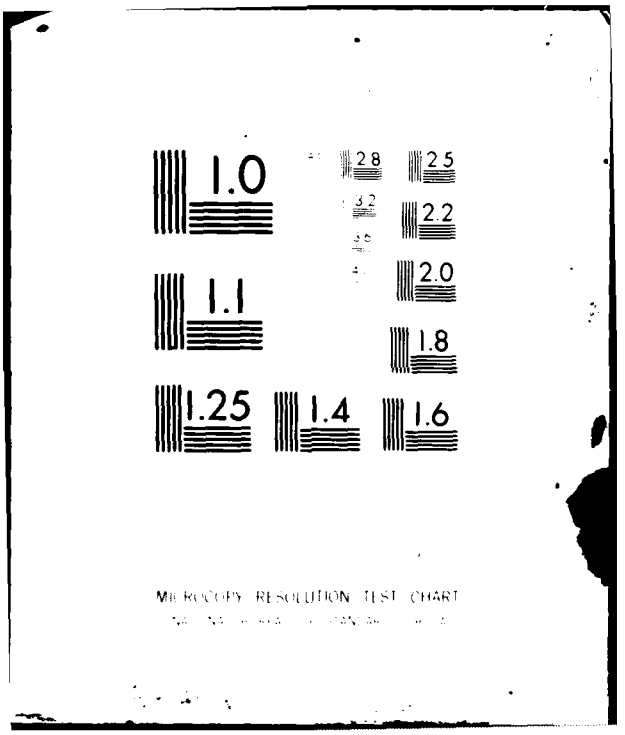
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The United States Defense Mapping Agency(DMA) designed the Automated Notice to Mariners System(ANMS) with the hardware and software capability to utilize modern communications systems. Not only does ANMS automation speed processing of the printed document, but, as an added benefit, use of present communications systems provedes a "real-time" means of disseminating DMA's chart corrections data on a global basis. The ANMS was also designed with sufficient flexibility to allow incorporation of new communication

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techniques such as shipboard satellite communications. The ANMS design allows multiple communication interfaces to be installed on DMA's Prime 400 computer for access to chart corrections data files. For example, the ANMS can support simultaneous remote queries from any or all of the following: a portable terminal calling over a dial-up telephone line from anywhere in the world(available); a telephone query from a ship at sea which is equipped with shipboard satellite system and a portable terminal(available); a TWX link(available); a Telex link(1982 time frame); and, data transfers via commercial data transmission networks(under study). Satellite data queries via MARISAT have already been successfully tested to show the capability of modern communications to obtain chart corrections by mariners while they are still at sea. To use a MARISAT receiver at present, requires users to have either a small inexpensive data terminal with an acoustic coupler attached or users to dial the DMA TWX number over the satellite Telex unit. To support remote telephone queries, there are six commercial data lines installed at DMA. The caller may now dial in on one of the available voice-grade, 300 baud lines. Several public-use ANMS program options are available to query the DMA chart corrections data base. Various advantages in use of communications to obtain data to correct charts at sea or in remote ports of the world are identified in this paper. Use of commercially available communications systems for chart corrections is a new and revolutionary capability, and factors such as reduction of insurance rates and burden of proof in marine accidents could greatly affect the future use of the ANMS.

CHART CORRECTIONS

VIA

GLOBAL COMMUNICATIONS SYSTEMS

By

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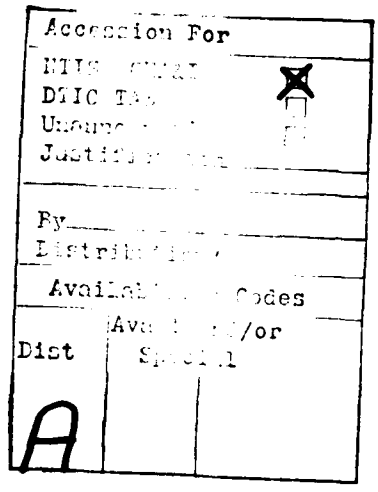

ABSTRACT

The United States Defense Mapping Agency (DMA) designed the Automated Notice to Mariners System (ANMS) with the hardware and software capability to utilize modern communications systems. Not only does ANMS automation speed processing of the printed document, but, as an added benefit, use of present communications systems provides a "real-time" means of disseminating DMA's chart corrections data on a global basis. The ANMS was also designed with sufficient flexibility to allow incorporation of new communication techniques such as shipboard satellite communications. The ANMS design allows multiple communication interfaces to be installed on DMA's Prime 400 computer for access to chart corrections data files. For example, the ANMS can support simultaneous remote queries from any or all of the following: a portable terminal calling over a dial-up telephone line from anywhere in the world (available); a telephone query from a ship at sea which is equipped with shipboard satellite system and a portable terminal (available); a TWX link (available); a Telex link (1982 time frame); and, data transfers via commercial data transmission networks (under study). Satellite data queries via MARISAT have already been successfully tested to show the capability of modern communications to obtain chart corrections by mariners while they are still at sea. Ships which are presently equipped with a MARISAT receiver and a small inexpensive data

terminal with an acoustic coupler attached may place a telephone call to DMA for Chart Corrections. To support these remote telephone queries, DMA has installed commercial data lines which are voice-grade, 300-baud lines. When the call is received by the ANMS computer, there are several public-use ANMS program options available to query the DMA chart corrections data base. Various advantages in use of communications to obtain data to correct charts at sea or in remote ports of the world are identified in this paper. Use of commercially available communications systems for chart corrections is a new and revolutionary capability, and factors such as reduction of insurance rates and burden of proof in marine accidents could greatly affect the future use of the ANMS.

INTRODUCTION

The Defense Mapping Agency assigned to its Hydrographic/Topographic Center (HTC) the responsibility for analyzing information concerning navigation on a worldwide basis and for notifying mariners, both merchant marine and naval, of all changes to its charts, publications and other products that affect safe navigation. The Automated Notice to Mariners System (ANMS) is a new, automated system specially designed to process, store, and typeset this information. It is a unique combination of commercially available hardware and custom-designed software.

The primary output of the ANMS is the computer type-set pages used to print HTC's Weekly Notice to Mariners, Summary of Corrections, Broadcast Warnings and, eventually, Lists of Lights and Sailing Directions. The software also has remote query capabilities for data retrieval which HTC has made available to the entire maritime community. This remote query capability is a revolutionary new resource for mariners never before available to support the safety of navigation and lives at sea. Not only will HTC's printed publications be produced faster and be available sooner to mariners in port, but mariners

using commercially available communications equipment can have the latest navigation information at sea. All users of HTC navigational products will benefit from the increase in data accessibility and the decrease in notification time.

ANMS COMMUNICATIONS DESIGN

The entire ANMS automation effort is based upon a phased development concept. Since the automation of the Notice to Mariners is such an extensive project, it is recognized that years will be required to complete the entire system. Another reason for the phased approach is that in today's computer industry the passage of time ensures progress in computer technology as well as cost variations in hardware and vendor supplied software.

For the development of ANMS communications, the phased approach has been especially useful. The initial ANMS design specified the capability to support four 300-baud, dial-up telephone lines for use with acoustic coupled, terminal communications. Also the original computer purchase specifications were written to allow interested vendors to secure additional evaluation points based upon the sophistication and expandability of their computer, peripherals, and company supplied software. This approach provided the initial ANMS hardware with a sound foundation which could be expanded as required. The original computer, a Prime 400, with 512K bytes of memory was capable of supporting up to 64 interactive, time-shared users. It was equipped with 16 asynchronous, programmable ports. The line speed for each port can be set at 110-baud, 134.5-baud, 300-baud, and 1200-baud. There are also a wide variety of communications controllers, data acquisition boards, control boards and general purpose interfaces which are available for use on the ANMS computer. Today most popular computer manufactures recognize the importance of communications to support data

processing; therefore, the marketplace will insure that the capability will be commercially avaibable for the ANMS computer to utilize new advances in communications.

Phase One of ANMS communications consisted of four dial-up telephone lines connected to modulator/demodulators (modems) and a Prime Asynchronous Multiline Controller (AMLC) which was set at 300-baud. The communications capability came into use from the very first day of installation in 1978 because Chart Corrections Subsystem programmers were then input/output bound on the system, and were quick to utilize the new ports for software development. This capability greatly assisted programmers in writing the Chart Corrections Subsystem, which serves to illustrate that communications are also a useful system tool. In addition to development of applications software, computer manufacturers can use communications links to check, debug, and reprogram their frequently changing system software.

After the chart corrections software was tested and accepted by DMA, a 6-month period was required to load and edit the chart corrections data base. During this time, all ANMS communcations were placed in standby mode. After the ANMS was in full production for printing the Weekly Notice to Mariners and periodic Summary of Corrections, DMA began a test period to determine operating procedures for the existing communication hardware and software. The requirements for accuracy of the digital chart corrections had to be the same as those applied to the printed Notice. The initial remote users during this test period were the DMA Field Office in Providence, Rhode Island; the International Aerial Mapping Company in San Antonio, Texas; and the Tennessee Valley Authority. These remote system users of the Chart Corrections Subsystem found it to be productive, and they continue to be very enthusiastic about the convenience and speed of ANMS system queries.

With the automation of chart corrections, all of DMA's published corrections are available directly from the ANMS data base. Such queries can be made on a 24-hour basis and can be accomplished without human intervention. It was immediately cost effective for many remote users to begin use of ANMS communications, especially when time is important. The only problems which were encountered during Phase One testing by dial-up telephone users were those which are common to the industry; namely, difficulty in obtaining a circuit during peak business hours and the existence of bad lines in some geographic areas. DMA's experience over the past year is that the ANMS does not transmit bad data, even when bad telephone lines are encountered, which is a very positive factor in system development. A remote user encountering a bad telephone line will be unable to sign-on to the computer. If sign-on is accomplished and if the data are garbled in transmission, this situation is easily detected because almost all commercially available terminals have the capability for parity checks. The American Standard Code for Information Interchange (ASCII) used by the ANMS is seven bits plus a parity bit. Thus, when a parity problem is detected most terminal systems will print some predetermined character such as an asterisk or a question mark. This forewarns the user that the transmission was bad and that remedial action is required.

As noted, DMA has not yet found an occurrence where a transmission error has actually yielded erroneous information. Generally, the results have been so positive during the testing period of the ANMS dial-up telephone service that DMA is now experimenting with an even faster line speed of 1200-baud. Two of these high-speed, dial-up lines have been in service on the ANMS system since October 1981 and they have yielded results which are comparable to the 300-baud service. For short or medium length data queries, the advantage of using high-speed lines and a dumb terminal is negligible. The time required to sign-on to the computer and type in the data query is largely dependent upon the skill of the human operator which makes the use of a high-speed line

uneconomical for a short query. Conversely, when the query requires transmission of large quantities of data, high-speed service will significantly shorten the connect time which will decrease costs if long distance dial-up telephone lines are being used.

The problems associated with configuring and maintaining a cost effective system are complicated by both rapidly changing technology as well as the difficulty in predicting actual traffic patterns of ANMS users. For example, use of new technology such as "smart" terminals with bubble memory will allow "instant" initiation of the log-on procedure. This will permit the remote terminal to transmit a query stored in memory "before" the telephone call is placed to the ANMS and use of such an advanced terminal is an alternative use of both the ANMS 300-baud and 1200-baud telephone services. Regardless of the line speed, the elimination of the requirement for interaction of the terminal user with the computer will save up to several minutes of telephone connect time.

The ANMS digital information system is not developing in a vacuum, therefore it should be viewed as simply one of many such ongoing automation efforts throughout industry and government. A user should not evaluate the cost effectiveness of dedicating a terminal and its associated devices for use only with the ANMS. The variety of accounting, ship maintenance and other ship operating uses for ship-to-shore communications and computer data bases is constantly growing. Papers presented at the International Symposium on Ship Operations on Nov 17-19, 1981 at New York, City projected an ever growing population of at-sea digital data users.

Dr. Gernot M.R. Winkler's paper entitled "The U.S. Naval Observatory Data Services" detailed one such data service, the Digital Data Access System (DDAS). That system is based upon one 300-baud dial-up line, and it offers a varied menu of programs

which provide navigation information on systems such as Omega, Transit, and Loran, and also furnishes time information. As might be expected, the type of data, as well as software and hardware details of DDAS, are different from those employed in the operation of the ANMS. However, these differences are largely transparent to mariners and other remote users because any user may place a call to either data base via a standard portable terminal and obtain digital navigation information.

Once problems associated with the Phase One, dial-up telephone service were surmounted, Phase Two of ANMS communications was begun and is scheduled for completion in 1982. Phase Two involves the implementation of TWX/Telex links and the establishment of a message-based query capability on the Prime Computer. Phase Three will be mentioned only briefly in this paper. Succeeding sections will provide greater details on present global communications services which now offer users a link to the ANMS data base.

DIAL-UP TELEPHONE SERVICE

It is hard to explain how important the common telephone has become to the modern computer world. It seems so simple and it has become such a part of everyday life that we have trouble envisioning it as a complex, man/machine interface. The extensive and dependable hardware/software of telephone companies makes it one of our more advanced data processing tools. Telephone service was selected for implementation as Phase One of ANMS communications because of the following:

1. Unlimited user access.
2. Existing global coverage.
3. Twenty-four hour availabilty.
4. Error checking capability available with off-the-shelf inexpensive hardware.

5. Technical advantages:

   a. full-duplex, interactive capability,

   b. variable baud, ASCII coding, and

   c. analog transmission media.

Presently there are five 300-baud dial-up telephone lines (202-227-3350) with the other four successive numbers operating on a rotary in service at HTC. These lines support asynchronous, full-duplex communications from remote terminals. This link is available on a continuous basis for chart correction queries to the ANMS. Before the remote terminal can obtain chart corrections, the Prime operating system requires that a valid user identification number be input in order to sign-on the system controller. This is now provided to all prospective users based upon a routine application. Once the system verifies the user identification number, the system prompts and assists the user to obtain chart correction information. Corrections for up to 10 charts may be obtained with a single query to the ANMS data base. This is designed to optimize expensive, long distance communications. Other programs to assist remote ANMS users are also under preparation.

Almost all modern ports and most shipping company offices/agents have links with world telephone networks; therefore, dial-up telephone service is, and will continue to be, DMA's priority system to serve remote Notice to Mariners users. Advances in terminal design as well as all other telephone system components will be carefully monitored for their utility towards improving ANMS service. For each telephone line, the ANMS uses a Penril 300B Modem which conforms to Bell System 103F type modems. The Penril modem is connected to the central telephone exchange in an answer-only mode. To broaden the number of usable terminals, to simplify user requirements, and to make applicable terminals as cheap as possible, only upper case letters are used in ANMS query programs.

Phase Two of ANMS communications is also based upon present dial-up capability and assumed technological advances in speed and accuracy of telephone system based terminals. If a sufficient population of users with a "smart" terminal can show a need for DMA to support this type of terminal, then there are many other more advanced communications options which might be offered. For example, if a line protocol were used, many more data transmission error conditions could be detected and handled better. With a smart terminal and a protocol in use, higher transmission speeds could be used and connect cost would be lowered. It should also be restated that the uses for a smart terminal are not exclusively based upon the Notice to Mariners as these devices are also capable of many other uses. As noted, DMA is only one of many organizations which seek to improve services by use of digital tools.

TWX COMMUNICATIONS SERVICE

The Teletypewriter Exchange Service (TWX) was selected to interface with the Prime because it could operate with a modem, an answer-back device, and connect to the Prime via a standard RS-232 connector. TWX is an analog teletype switched message service. One major advantage for its use with a computer is that it uses ASCII coding. The data speed is 110 baud, asynchronous with two stop bits and prints at 100 words per minute (WPM). Coverage is essentially Continental U.S. which limits its utility for serving the global needs of the ANMS; however, Telex units on international circuits have the option to call a U.S. based TWX number. In such a case, the international carrier performs the necessary speed and code conversions (from eight-level ASCII for TWX to five-level Baudot for Telex). U.S. based Telex units do not now have this computer conversion service but it is expected to become available in 1982. The previously mentioned answer-back device installed on our TWX line satisfies the requirement of the Telex system for an indication that the TWX station is free and that it can accept the

incoming Telex call. Without the answer-back unit, neither the telephone line modem or the computer could acknowledge the proper signal required to complete a Telex call to a TWX number. DMA's TWX number is 710-824-0551 and is operational (however, Telex to TWX service is still being tested at DMA). Query procedures for TWX are the same as for dial-up telephone service.

Since TWX is primarily a message system, DMA elected to install it on the ANMS as a part of Phase Two instead of Phase One. This turned out to be a good decision, from a system management point of view, because of the problems which were encountered in interfacing the TWX system to the Prime Computer. Even though all of the hardware and software were off-the-shelf, the combination and usage was a first-time development effort.

TWX operates in a half duplex mode and users cannot execute the equivalent of a "Command S" to interactively stop a query before it is complete (now available on a telephone system based terminal). This capability can be selected at any point with the dial-up terminal when that terminal is outputting data from the computer. This capability is important because it allows users the option of aborting a query for any reason. This is especially important when one considers the relatively slow transmission speed of TWX. Although many Notice to Mariners subscribers already have the hardware for TWX communications, our experience with its slow speed during testing and evaluation has influenced our decision to also look at higher speed data transmission networks and devices.

TELEX SERVICE

The telex line to the ANMS is 908140 and it is expected to be operational in 1982. Problems encountered with code and speed conversions which are necessary to interface it

to the ANMS are now being resolved. There are five major worldwide telex vendors: RCA Global Communications; Telecommunications Radioelectriques and Telephoniques (TRT); Western Union International (WUI); ITT World Communications (ITTWC); and, the French Telegraph Cable Company (FTCC). Satellites and transoceanic cable are both used to transmit their services. Telex is the slowest of the potential ANMS carriers because it is 50 baud or 66 2/3 WPM. Besides being an international communications system, another advantage of Telex is that overseas users of Telex may access the ANMS through Western Union's, Domestic TWX or Telex services as soon as it becomes operational on the ANMS. Code and speed conversions for international users are performed interactively and are transparent to users. Cost is established by international treaty and rates may vary depending upon the country.

Satellite shipboard receivers incorporate a Telex unit and this will allow ship-to-shore queries to the ANMS data base without installation or use of any other equipment. Telex uses a five-level Baudot code and this must be converted to ASCII code "before" it is input to the Prime Computer. There are several inexpensive code converters available which operate at half-duplex and can also buffer the message to slow the data rate. For use of Telex-to-computer communications, one other line device, a line driver, is required. This performs a digital to analog signal conversion to allow proper use of the Telex network.

ADVANTAGES OF USE OF REMOTE QUERY CAPABILITIES FOR MARINERS

Even though the chart corrections query capability has only been available for several months by commercial shipping, DMA has received some very favorable comments from users. Users queried the ANMS with portable terminals which were linked to the ANMS data base via a MARISAT voice grade, dial-up telephone line. Most shipping

companies which have applied for an ANMS user ID number say that they plan to utilize the digital link as a means of decreasing the time required to correct their charts as well as a means of insuring that the very latest chart corrections are available. As the size and speed of ships have increased, conversely the size of the crews and the time that can be devoted to the important task of correcting charts aboard ship have decreased. To remedy this situation, a few other hydrographic agencies have provided supplementary materials with their Notice to Mariners to alleviate chart correction tasks. Such additional material can be helpful, but it can also increase the shipboard workload. The main benefit offered by DMA's approach is that shipboard personnel can specify the exact information desired and then know that the results represent the latest navigational information available via the ANMS. Commercial users also note the advantage that the ANMS offers if an unplanned route change is made. The latest chart corrections may be obtained without looking at volumes of weekly and Summary of Corrections, because in such a situation, the needed chart may not have had any corrections applied. Also, if a ship has been at sea for some time, it will not have the latest published weekly Notice to Mariners on board.

In addition to chart corrections, the ANMS data base also contains Broadcast Warning messages. These warnings may be queried for geographic subregions which are referenced to the Geographic Locator found in the front of the Weekly Notice to Mariners. The text for one or more messages which are in effect may be requested by remote users. These warnings are issued on a daily basis and this capability is a valuable addition to the ANMS. It is now predictable that the ANMS will serve mariners in future emergency situations, because the data on the system has the potential to help protect the safety of lives and property at sea.

CONCLUDING REMARKS

The flexability of the ANMS design insures the future capability of the Automated Notice to Mariners System to serve remote users. Our Phase Three will be based upon the needs of Notice to Mariners users which are to be identified during the year 1982. Phase Three will reflect the mature communications capabilities for the ANMS. As noted earlier, this does not preclude a user from requesting DMA to support a different communcations system or device. However, to identify a significant population of users for such a new service and for DMA to install it on the ANMS will require time.

It is almost impossible to predict the capabilities which may be installed beyond Phase Three of the ANMS because almost all services utilized by DMA communications are undergoing rapid technological advances. Since the Notice to Mariners is now a computer-based publication, many of the problems normally associated with the use of new communications technology will be lessened. Today, software can offer solutions to many complicated interface and data transmission problems which are encountered upon installation of new communcations services. Even though the problems involved in the use of this new technology seem large, we should not forget that our Prime Computer is a very powerful communications, front-end device and that it can be programmed to solve most problems.

Organizations such as the Sea Use Council have made proposals which seek to integrate present and future marine telecommunications systems to benefit industry as a whole. Implementation of their proposals would make a variety of data such as Worldwide Navigational Warnings available to ships at sea from a cooperative data base. Since the Prime computer can be equipped for computer-to-computer communications, the query and data transfer from the ANMS to other international systems is also feasible. All of

these systems place heavy reliance upon a new organzation, INMARSAT, the International Maritime Satellite Organization. A major advance offered by INMARSAT is the location of multiple coast earth stations in each ocean region. The INMARSAT system will be compatible with the characteristics of the MARISAT system. From the ANMS viewpoint the increased number of users and potential reduction or user tariffs for calls are important advantages and planning considerations.

DMA has now introduced the new and revolutionary ANMS communications capability for Notice to Mariners users and has linked it to the most popular global communications services. All necessary hardware and software have been installed and most of the planned communications capabilities are operational. The user, can now influence which of these services will be kept beyond 1983 as well as helping DMA to determine new services for future implementation. With the basic system now available, DMA will await the accumulation of user statistics and receipt of user feedback with great interest.

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